



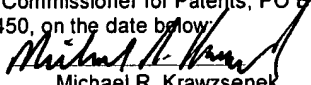
IFW

PATENT

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Title: ABSORBENT HYDROPHOBIC BORONATE  
GALACTOMANNAN COMPLEXES AND PROCESS FOR  
PRODUCING SAME

Appl. No.: 10/596,578 ✓  
Applicant: Couffin *et al.*  
Filed: Concurrently  
TC/A.U.: Not Yet Assigned  
Examiner: Not Yet Assigned  
Docket No.: BRKP:025US  
Customer No.: 32425  
Confirmation No. 8020

CERTIFICATE OF MAILING 37 C.F.R. 1.8	
I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450, on the date below: August 16, 2006	
Date	 Michael R. Krawzsenek

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

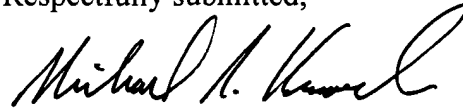
**SUBMISSION OF FOREIGN PRIORITY DOCUMENT AND  
CLAIM FOR FOREIGN PRIORITY PURSUANT TO 37 C.F.R. § 1.55**

Sir:

Applicants have previously claimed priority to Canada Patent Application No. 2,507,121,  
filed May 12, 2005, for the above-referenced application. Applicants enclose a certified copy of  
the Canada priority patent application.

While it is believed that no fees under 37 C.F.R. §§ 1.16 to 1.21 are occasioned by the filing of this request, should the Commissioner determine otherwise, the Commissioner is hereby authorized to deduct said fees from Fulbright & Jaworski Deposit Account No. 50-1212/BRKP:025US.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Michael R. Krawzsenek". The signature is fluid and cursive, with a large, sweeping loop at the end.

Michael R. Krawzsenek  
Reg. No. 51,898  
Attorney for Applicant

FULBRIGHT & JAWORSKI L.L.P.  
600 Congress Avenue, Suite 2400  
Austin, Texas 78701  
512.536.3020 (voice)  
512.536.4598 (fax)

Date: August 16, 2006



Office de la propriété  
intellectuelle  
du Canada

Un organisme  
d'Industrie Canada

Canadian  
Intellectual Property  
Office

An Agency of  
Industry Canada


*Bureau canadien  
des brevets  
Certification*

*Canadian Patent  
Office  
Certification*

La présente atteste que les documents  
ci-joints, dont la liste figure ci-dessous,  
sont des copies authentiques des docu-  
ments déposés au Bureau des brevets.

This is to certify that the documents  
attached hereto and identified below are  
true copies of the documents on file in  
the Patent Office.

Specification, as originally filed, with Application for Patent Serial No: CA 2507121, on  
May 12, 2005, by **LE GROUPE LYSAC INC.**, assignée of Mohammed Berrada,  
Anne-Claude Couffin-Hoarau and André Laforest, for "Galactomannan Hydrophobic  
Complexes as Superabsorbent Polymers"

  
Agent certificateur/Certifying Officer

June 19, 2006

Date

Canada

(CIPO 68)  
31-03-04

OPIC  CIPO

**ABSTRACT OF THE DISCLOSURE**

The present invention relates to superabsorbent materials comprising galactomannans. The said galactomannans comprise hydrophobic complexes.

**TITLE OF THE INVENTION**

GALACTOMANNAN HYDROPHOBIC COMPLEXES  
AS SUPERABSORBENT POLYMERS

**FIELD OF THE INVENTION**

5                   The present invention relates to absorbent or superabsorbent galactomannan derivatives, as well as methods for producing same.

**BACKGROUND OF THE INVENTION**

10                   Water absorbent materials such as superabsorbent polymers can be employed in various applications, such as in disposable sanitary products (for example, diapers, incontinence articles, feminine hygiene products, airlaids and absorbent dressings), household articles, sealing materials, humectants for agricultural products for soil conditioning, oil-drilling (lost-circulation material), anti-condensation coatings, water-  
15                   storing materials in agriculture/horticulture, absorbent paper products, bandages and surgical pads, pet litter, wound dressings, and as chemical absorbents. Furthermore, they can be employed in applications related to the transportation of fresh food or seafood, and in food packaging applications.

20                   The largest use of superabsorbent materials (also referred as SAP), however, is in disposable personal hygiene products. Those products include, in order of volume of superabsorbent material used, diapers, training pants, adult incontinence products and feminine hygiene products.

Biodegradability and sustainable development issues were raised recently in the superabsorbent industry, as oil price increases created provisioning problems. As alternative, Groupe Lysac® proposed many absorbent compositions made from biodegradable and renewable feedstocks (Huppé *et al.* CA 2,308,537; Couture *et al.* CA 2,362,006; Bergeron CA 2,426,478; Thibodeau *et al.* CA 2,462,053; Berrada *et al.* CA 2,483,049).

The use of galactomannans, cross-linked with borate, titanium or zirconium ions, as superabsorbent polysaccharides, has been disclosed in a number of patents: US P 4,624,868; US P 4,333,461; JP 2002-253961; JP 2002-035037; JP 2001-278998; JP 2002-037924; JP 2002-053859; JP 2001-120992; JP 2002-053859; and JP 2001-226525. Borax-based galactomannan nanocomposites even exhibited Free Swell Capacities of 135 g/g, as described by Berrada *et al.* (CA 2,483,049).

In despite of their superior absorbent properties, cross-linked galactomannans gels need to be dried, in order to yield good absorbent materials. Dried galactomannans are also easily mixed in diapers and easily handled. Among known gel drying techniques, heat drying, lyophilization, and solvent precipitation were described.

Cottrell *et al.* (US P 5,536,825 and US P 5,489,674) disclosed the use of solvent (methanol or isopropanol) purified galactomannans as absorbent polysaccharides. Furthermore, Annergren *et al.* (WO 0021581A1) disclosed that soaking cross-linkable polysaccharides in methanol provides a material exhibiting superior absorbency.

Solvent precipitation (methanol, ethanol, isopropanol, acetone, acetonitrile) is preferred among previously cited patents. Solvent

precipitated gels yield very good absorbent characteristics. However, industrial solvent manipulation is very expensive, because solvents need to be recycled. Solvents are also very flammable, highly toxic and cannot be disposed safely in the environment.

5                   Lyophilization is a complex, expensive and batch or semi-batch process. Moreover, lyophilisation will sometimes lower performances of absorbent galactomannans. Heat drying is a very simple process, which could be scaled-up in a continuous process easily. However, heat drying galactomannans gels will dramatically decrease their  
10 absorbent characteristics. Borax-galactomannan gels are known to decrease up to 10 times their absorption capacities, when heat dried, by comparison to solvent dried gels.

                  There thus remains a need for an efficient superabsorbent based on galactomannans. The said superabsorbent  
15 would be easily dried by heat drying techniques. The heat drying technique would only have a slight effect on superabsorbent performances, compared to solvent precipitated galactomannans.

                  The present invention seeks to meet these and other needs.

20                   The present invention refers to a number of documents, the content of which is herein incorporated by reference in their entirety.

#### **SUMMARY OF THE INVENTION**

25                   A good way to solve the problems of drying would be to design a galactomannan superabsorbent retaining (at least 50 %) the properties of solvent dried galactomannans, when heat-dried. It was

surprisingly found that galactomannan, complexed with hydrophobic groups, solved this problem.

The present invention relates to superabsorbent materials comprising galactomannans, wherein said galactomannans  
5 comprises hydrophobic complexes.

The present invention also relates to the use of the superabsorbent materials comprising galactomannans, wherein said galactomannans comprises hydrophobic complexes. More specifically, those superabsorbent galactomannans are useful in disposable sanitary  
10 products such as for example, diapers, incontinence articles, feminine hygiene products, airlaids and absorbent dressings. Moreover, the present invention relates to the use of the superabsorbent galactomannan comprising hydrophobic complexes in household articles, sealing materials, humectants for agricultural products for soil conditioning, mining  
15 and oil drilling, anti-condensation coatings, water-storing materials in agriculture/horticulture/forestry, absorbent paper products, bandages and surgical pads, absorbents for chemical spills, polymeric gels for cosmetics and pharmaceuticals, artificial snow and in fire-fighting techniques. Furthermore, the present invention relates to the use of superabsorbent  
20 materials comprising galactomannans, wherein said galactomannans comprises hydrophobic complexes in applications related to the transportation of fresh food or seafood as well as in food packaging applications.

In a further preferred embodiment, the present  
25 invention also relates to the use of superabsorbent materials comprising galactomannans, wherein said galactomannans comprises hydrophobic



complexes, for absorbing liquids, non-limiting examples of which include water, aqueous solutions, physiological fluids and saline solutions.

The present invention also relates to compositions including a superabsorbent material comprising galactomannans, wherein  
5 said galactomannans comprises hydrophobic complexes, and a co-absorbent material.

Finally, the present invention relates to methods for preparing superabsorbent material comprising galactomannans, wherein said galactomannans comprises hydrophobic complexes.

## 10 **DETAILED DESCRIPTION OF THE INVENTION**

The present description refers to a number of routinely used chemical terms. Nevertheless, definitions of selected terms are provided for clarity and consistency.

### **Definitions**

15 As used herein, the term "Free Swell Capacity" (FSC), also called "Total Absorption" refers to the amount (g) of fluid absorbed per gram of the composition. Typical fluids are saline solutions (0.9% Weight/Weight NaCl solution, hereinafter called 0.9% NaCl solution or saline).

20 As used herein, the term "Centrifuge Retention Capacity" (CRC) also called "Retention", refers to the amount (g) of fluid retained per gram of the composition, following exposure of the composition to a centrifugation force of 250G. Typical fluids are saline solutions (0.9% Weight/Weight NaCl solution, hereinafter called 0.9% NaCl  
25 solution or saline).

As used herein, the term "Absorption Under Load"

(AUL) at 0.3 PSI, 0.7 PSI or 0.9 PSI, also called "Absorption Against Pressure" (AAP), refers to the amount (g) of fluid absorbed per gram of the composition under a given applied pressure. Typical fluids are saline solutions (0.9% Weight/Weight NaCl solution, hereinafter called 0.9% NaCl solution or saline).

As used herein, the term "superabsorbent" or "superabsorbent polymer" or SAP refers to polymers which form gels upon contact with water, saline, or physiological fluids. Those polymers are characterized by a high absorption level, more specifically a Free Swell Capacity (FSC) of at least 15 g/g.

As used herein, the term "galactomannan" refers to naturally occurring polysaccharides consisting of a poly  $\beta$ -(1-4)-mannose backbone having varying degrees of substitution (DS), to which single D-galactopyranosyl residues are attached via  $\alpha$ -(1-6) linkages. Non-limiting examples of galactomannans are guar gum, locust bean gum, tara gum, fenugreek gum, mesquite gum and mixture thereof. Endosperms of coffee (US App. 2004/0199943 A1), alfalfa, red-clover and some soybeans (US App. 2004/0143871 A1) are also known to comprise galactomannans.

As used herein, the term "diols" refers alcohol functions of galactomannans able to react with complexing agents. As reported by Bishop *et al.* (Dalton; (17); 2004; PP. 2621-2634) most reactive sites able to react with complexing agents are 3-4 *trans*-diols on galactopyranosyl residues and 2,3-*cis*-diols on the mannose backbone. Those sites are underlined in scheme 1.

As used herein, the term "complex" refers to interactions between diols of galactomannans and diol complexing agent.

As used herein, the term "diol complexing agent"

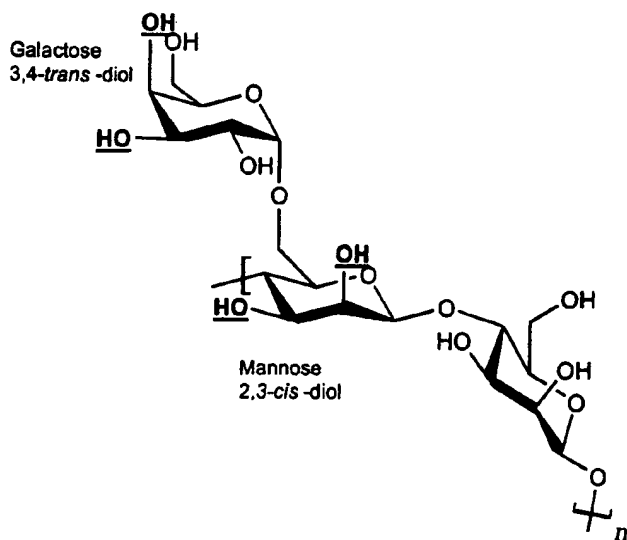
refers to molecules able to form complexes with diols. Usually, diol complexing agent comprises an element able to complex with diols. Non-limiting examples of such elements are borates, boric acids or transition metals hydroxides able to form complex with cis-diols. Non-limiting  
5 examples of such transition metals are iron, zirconium and titanium. A mixture of elements complexing diols would also be suitable.

As used herein, the term "hydrophobic complex" refers to complexes, wherein the diol complexing agent comprises a hydrophobic moiety.

10 In a broad sense, the present invention relates to superabsorbent materials comprising a complexed galactomannan. More specifically, the galactomannan is complexed with cis-diol complexing agents comprising a hydrophobic moiety.

Yet more specifically, preferred galactomannans to be  
15 used could be selected from the group consisting of guar gum, locust bean gum, tara gum, fenugreek gum, mesquite gum and mixture thereof. Endosperms of coffee (US App. 2004/0199943), alfalfa, red-clover and some soybeans (US App. 2004/0143871 A1) are also known to comprise galactomannans. Galactomannans having a galactose/mannose  
20 substitution ratio ranging from 1:5 to 1:1 are preferred.

Among galactomannans, guar gum is preferred. Guar gum is derived from ground endosperm of the guar plant, which is grown extensively in the semi-arid regions of Pakistan and India. As shown below in Scheme 1, the structure of guar gum comprises a random galactose  
25 substitution ratio of 1.6:1. This ratio is subject to fluctuations from crop to crop or from subspecies to subspecies (Jasinski *et al. J. of Polym. Sci.*, part. B, 1996, 34, pp.1477-1488).



Scheme 1

When guar solutions are heat dried, such as in a convection oven, galactomannan molecules will be placed in contact with air, creating an air-solution interface. Without being bound to any theory, it is believed that galactomannans will reorient their more hydrophobic regions to the air-solution interface. Therefore, hydrophobic regions will be located at the outer surface of dried galactomannans. When galactomannans will re-hydrate, those outer-located hydrophobic regions will therefore interact with swelling mechanisms of guar. This phenomenon will therefore lower absorbent properties of heat-dried galactomannans and cross-linked galactomannans.

It was unexpectedly discovered that; by grafting hydrophobic complexes on galactomannan; it was possible to obtain heat dried galactomannans with absorption properties comparable to solvent precipitation techniques. This was done by using diol complexing agent comprising an hydrophobic group.

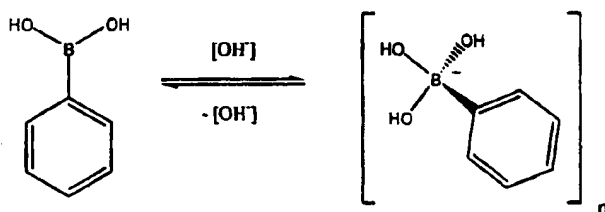
Diol complexing agents are known in the art to complex with D-galactopyranosyl residues of galactomannans. D-galactopyranosyl residues are also known to give swelling power to galactomannans. By providing a diol complexing agent with an hydrophobic moiety, D-galactopyranosyl residues will react with the diol complexing agent and bear an hydrophobic group. Without being bound to any theory, it is believed that those hydrophobic groups will reorient the heat-dried galactomannan, in a manner that it will not be affected by air-solution surface interactions.

Diol complexing agent could be various. They must, however, contain an element able to complex with diols. Non-limiting examples of such elements are iron oxides, titanium oxides and zirconium oxides. However, it was found that diol complexing agents comprising borates or boric acid were particularly suitable for the present invention. A mixture of diol complexing agents or elements could also be suitable.

In order to provide heat-drying stability, the diol complexing agent should comprises an hydrophobic group. A non limiting example of such hydrophobic group is the phenyl group. Phenylboronic acid and phenylboronate were preferred among diol complexing agents.

As reported in the literature (Bishop *et al.*; Dalton; (17); 2004; PP. 2621-2634; Pezron E. *et al. Macromolecules*, 1988, 21, 1121-1125; Jasinski R. *et al., J. Polym. Sc. Part B-Polym. Phys.*, 1996, 34, 1477-1488), borate species will change over pH. It was found that pH ranging from 8.5 to 10.5 is especially suitable to yield galactomannans with good absorption properties. As reported by Bishop, phenylboronic acid will form a phenylboronate at pH ranging from 8.5 to 10.5. Phenylboronate is preferred as hydrophobic complexing agent. It was found that

phenylboronate is more likely to react with swelling diols of galactomannan. Phenylboronic acid phenylboronate equilibrium is defined in scheme 2.



*Scheme 2*

5                   The complexed galactomannans of the present invention may, in addition of complexation, be cross-linked. Indeed various cross-linkers may be used to prevent solubilization of galactomannans. Non-limiting examples of crosslinking agents include, but are not limited to borax, borates, boric acid, glyoxal, epichlorohydrin, sodium  
10 trimetaphosphate, sodium tripolyphosphate, phosphorous oxychloride and mixtures thereof. Additional non-limiting examples of crosslinkers known in the art include succinyl dichloride, acryloyl chloride, butanediol diglycidyl ether, ethanediol diglycidyl ether, pyromellitic dianhydride, divinylsulfones, diisocyanates, alkylene bisacrylamides and mixtures thereof. A particularly  
15 preferred crosslinking agent is boric acid or borax.

                  The superabsorbent galactomannan complexes or compositions of the present invention may be incorporated into absorbent personal hygiene products such as, for example, baby diapers, incontinence products, sanitary napkins and the like. They may be also  
20 used in absorbent members such as absorbent cores, airlaids or foamed structures.

                  The superabsorbent galactomannan complexes or compositions of the present invention may also be used in several other

applications such as in food pads, in agricultural and forestry applications for the retention of water in the soil and for the release of water to the roots of plants and trees; in fire-fighting techniques; in bandages and surgical pads; for the cleanup of acidic or basic solution spills, including water  
5 soluble chemical spills; as polymeric gels for the controlled release of cosmetics and pharmaceuticals (also known as drug delivery systems); and in artificial snow.

The superabsorbent galactomannan complexes of the present invention may be mixed with other co-absorbent materials to  
10 provide superabsorbent compositions. In a preferred embodiment, the superabsorbent compositions comprise from about 1 to about 99% (w/w) of nanocomposite material, and from about 99 to about 1% (w/w) of co-absorbent material. Non-limiting examples of co-absorbent materials include synthetic superabsorbent polymers, starch absorbents, ionic  
15 polysaccharides, fibers and mixtures thereof.

In a more preferred embodiment, superabsorbent compositions are prepared by mixing the galactomannan complexes of the present invention with ionic polysaccharides; either cationic or anionic polysaccharides or mixtures thereof. In yet a more preferred embodiment,  
20 superabsorbent compositions are prepared by mixing the galactomannan complexes of the present invention with one or more anionic polysaccharides. Non-limiting examples of anionic polysaccharides include carboxyalkyl polysaccharides, carboxymethyl cellulose, carboxymethyl starch, oxidized polysaccharides, xanthan, carrageenans, pectin and  
25 mixtures thereof. Non-limiting examples of fibers include cellulose, viscose, rayon, cellulose acetate, Nylon<sup>TM</sup>, polyalkylenes, polyethylene, polypropylene, bi-component fibers, polyesters, polylactides, polypropanediols, Lyocell<sup>TM</sup>, sphagnum and mixtures thereof. Non-limiting

examples of starch absorbents are glass-like starches (as described by Huppé *et al.* CA 2,308,537), starch agglomerates, amylopectin networks (as described by Thibodeau *et al.* CA 2,462,053), hydroxyethyl starch, hydroxypropyl starch, carboxymethyl starch, starch nanocomposites (as described by Berrada *et al.* CA 2,483,049) and mixtures thereof.

The synthetic superabsorbent polymers to be incorporated into the superabsorbent compositions can be generally obtained from the polymerization, preferably by radical or radical graft polymerization, of monomers, non-limiting examples of which include acrylic acid, acrylate salts, acrylic ester, acrylic anhydride, methacrylic acid, methacrylate salts, methacrylic esters, methacrylic anhydride, maleic anhydride, maleic salts, maleate esters, acrylamide, acrylonitrile, vinyl alcohol, vinyl pyrrolidone, vinyl acetate, vinyl guanidine, aspartic acid, aspartic salts and mixtures thereof.

In a further preferred embodiment, the present invention also relates to the use of superabsorbent materials comprising galactomannans, wherein said galactomannans comprises hydrophobic complexes, for absorbing liquids, non-limiting examples of which include water, aqueous solutions, physiological fluids and saline solutions.

Another aspect of the present invention is a process for the manufacture of superabsorbent galactomannan hydrophobic complexes, comprising the steps of :

- Dissolving galactomannan in an aqueous solution.
- Complexing the galactomannan with a diol complexing agent comprising an hydrophobic group.
- Recovering the complexed galactomannan by heat-drying.



## **EXPERIMENTAL**

### **Materials**

Guar gum (Procol®) was obtained from Polypro  
5 (Minneapolis, USA). Phenylboronic acid and borax were obtained from  
Sigma-Aldrich (St-Louis, USA). Research grade methanol, hydrochloric acid  
and sodium hydroxide were obtained from Labmat (Beauport, Canada).

### **Convection oven**

Samples were dried in a Lab tray drier TY 2, National  
10 Drying Machinery Company, (Philadelphia, USA).

### **Grinder**

A Braun™ model KSM grinder was used to grind  
samples.

### **Test methods**

15 As discussed in Modern Superabsorbent Polymer  
Technology (Buchholz F.L. and Graham A.T. Eds., Wiley-VCH, New York,  
1998, section 4.6.1. Swelling Capacity: Theory and Practice, p. 147),  
several methods of measurement are used in order to characterize the  
swelling capacity of a polymer. In the field of superabsorbents, the  
20 Gravimetric Swelling Capacity [also called the Free Swell Capacity (FSC)]  
and the Centrifuge Capacity [also called the Centrifuge Retention Capacity  
(CRC)] are recommended methods. The FSC and the CRC were used to  
compare the swelling capacities of the obtained absorbent products.

**AUL measurements**

The Absorption Under Load (AUL) in a 0.9% NaCl solution at 0.7 PSI was determined according to the recommended test method 442.2-02 from EDANA.

**5    Tea bags for FSC and CRC measurements**

Tea bags (10 X 10 cm) were made from heat sealable Ahlstrom™ filter paper (16.5 ±0.5) g/m<sup>2</sup>.

**FSC measurements**

10    The Free Swell Capacity (FSC) in a 0.9% NaCl solution was determined according to the recommended test method 440.2-02 from EDANA.

**CRC measurements**

15    The Centrifuge Retention Capacity (CRC) in a 0.9% NaCl solution was determined according to the recommended test method 441.2-02 from EDANA.

**EXAMPLES****EXAMPLE 1****PHENYLBORONATE GUAR COMPLEXES AT pH 10**

A mixture comprising 12.002 g of guar gum and 600 ml of water was prepared. Separately, 0.723 g of phenylboronic acid was dissolved in 80 ml of water and pH of the resulting solution was adjusted to 10.0 with sodium hydroxide. The phenylboronate solution was added to the guar mixture and stirred 25 minutes. 150 ml of the resulting gel was blended with methanol (350 mL), triturated, and transferred into a beaker. The pH was adjusted to 7.88 under vigorous mechanical stirring using hydrochloric acid (10%). The so-obtained solid was filtered, washed with methanol (3 X 50 ml), dried overnight at 60°C in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 1. Another 150 ml of the gel resulting from the mixture of the aqueous guar solution and the phenylboronate solution was taken. The gel pH was adjusted to 7.91. The gel was dried in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 1.

**Table 1:** Performance characteristics of the guar-phenylboronate complexes

Drying Technique	FSC found (g/g)	CRC found (g/g)	AUL found (g/g)
Methanol	43	34	3.2
Heat	35	31	5.7

**EXAMPLE 2****PHENYLBORONATE GUAR COMPLEXES AT pH 9**

A mixture comprising 11.999 g of guar gum and 600 ml of water was prepared. Separately, 0.723 g of phenylboronic acid was dissolved in 20 ml of water and pH of the resulting solution was adjusted to 9.0 with sodium hydroxide. The phenylboronate solution was added to the guar mixture and stirred 45 minutes. 150 ml of the resulting gel was blended with methanol (350 mL), triturated, and transferred into a beaker. The pH was adjusted to 7.97 under vigorous mechanical stirring using hydrochloric acid (10%). The so-obtained solid was filtered, washed with methanol (3 X 50 ml), dried overnight at 60°C in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 2. Another 150 ml of the gel resulting from the mixture of the aqueous guar solution and the phenylboronate solution was taken. The gel pH was adjusted to 7.88. The gel was dried in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 2.

**Table 2:** Performance characteristics of the guar-phenylboronate complexes at pH 9

Drying Technique	FSC found (g/g)	CRC found (g/g)	AUL found (g/g)
Methanol	47	37	4.1
Heat	33	28	5.7

**EXAMPLES 3-7****pH IMPACT ON PHENYLBORONATE GUAR COMPLEXES**

A mixture comprising 3.000 g of guar gum and 150 ml of water was prepared. Separately, 0.181 g of phenylboronic acid was dissolved in 20 ml of water and pH of the resulting solution was adjusted to 7. Other samples were repeated, but pH of the phenylboronic solution was adjusted to pH 8, 9, 10 and 11. The phenylboronate solution was added to the guar mixture and stirred 25 minutes. 150 ml of the resulting gel was blended with methanol (350 mL), triturated, and transferred into a beaker.

The pH of the various precipitated gels was adjusted to 7.81; 7.82; 7.96; 7.86; and 8.01 respectively, under vigorous mechanical stirring using hydrochloric acid (10%). The so-obtained solid was filtered, washed with methanol (3 X 50 ml), dried overnight at 60°C in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 3.

**Table 3:** Impact of pH on performance characteristics of the guar-phenylboronate complexes

pH of phenylboronate complexes	FSC found (g/g)	CRC found (g/g)	AUL found (g/g)
7	24	23	5.3
8	27	23	5.6
9	29	25	6.1
10	38	33	4.0
11	39	33	3.4

**EXAMPLE 8****BORAX PHENYLBORONATE GUAR COMPLEXES**

A mixture comprising 3.002 g of guar gum and 150 ml of water was prepared. Separately, 0.203 g of phenylboronic acid was dissolved in 20 ml of water. To this solution, 20 ml of borax solution is added (20 mL; 5.65 g of borax in 200 ml of deionized water). pH of the resulting solution was adjusted to 9.6. The phenylboronate solution was added to the guar mixture and stirred 25 minutes. 150 ml of the resulting gel was blended with methanol (350 mL), triturated, and transferred into a beaker. The pH was adjusted to 7.99 under vigorous mechanical stirring using hydrochloric acid (10%). The so-obtained solid was filtered, washed with methanol (3 X 50 ml), dried overnight at 60°C in a convection oven and ground to provide a white particulate powder having the characteristics shown in Table 4.

**Table 4:** Performance characteristics of the borax-phenylboronate guar complexes

Sample number	FSC found (g/g)	CRC found (g/g)	AUL found (g/g)
8	104	90	7.8

**CLAIMS:**

1. A superabsorbent material comprising a galactomannan, wherein said galactomannan comprises a hydrophobic complex.
- 5 2. A superabsorbent material, as defined in claim 1, wherein the hydrophobic complex comprises galactomannan diol and a diol complexing agent.
3. A superabsorbent material, as defined in claim 2, wherein the diol complexing agent comprises a hydrophobic group.
- 10 4. A superabsorbent material, as defined in claim 3, wherein the hydrophobic group is a phenyl group.
5. A superabsorbent material, as defined in claim 2, wherein the diol complexing agent comprises an element able to complex with diols.
- 15 6. A superabsorbent material, as defined in claim 5, wherein the element able to complex with diols is selected from the group consisting of borates, boric acids, titanium hydroxides, iron hydroxides, zirconium hydroxides and mixture thereof.
7. A superabsorbent material, as defined in claim 20 1, wherein the galactomannan is selected from the group consisting of guar gum, locust bean gum, tara gum, fenugreek gum, mesquite gum and mixture thereof.
8. A superabsorbent material, as defined in claim 7, wherein the galactomannan is a guar gum.

9. A superabsorbent material, as defined in claim 1, wherein the galactomannan is cross-linked.

10. A superabsorbent material, as defined in claim 9, wherein the galactomannan is cross-linked with crosslinking agents selected from the group consisting of borax, boric acid, borates, glyoxal, epichlorohydrin, sodium trimetaphosphate, sodium tripolyphosphate, phosphorous oxychloride, succinyl dichloride, acryloyl chloride, butanediol diglycidyl ether, ethanedioldiglycidyl ether, pyromellitic dianhydride, divinylsulfones, diisocyanates, alkylene bisacrylamides and mixtures thereof.

11. An absorbent composition comprising a superabsorbent material as defined in claim 1, and at least one co-absorbent material.

12. The absorbent composition of claim 11, wherein the co-absorbent material is selected from the group consisting of synthetic superabsorbent polymers, starch absorbents, ionic polysaccharides, fibers and mixtures thereof.

13. The absorbent composition of claim 12, wherein the synthetic superabsorbent polymers are based on monomers selected from the group consisting of acrylic acid, acrylate salts, acrylic ester, acrylic anhydride, methacrylic acid, methacrylate salts, methacrylic esters, methacrylic anhydride, maleic anhydride, maleic salts, maleate esters, acrylamide, acrylonitrile, vinyl alcohol, vinyl pyrrolidone, vinyl acetate, vinyl guanidine, aspartic acid, aspartic salts and mixtures thereof.



14. The absorbent composition of claim 12, wherein the mannose-based polysaccharides are selected from the group consisting of glass-like starch, starch agglomerates, amylopectin networks, hydroxyethyl starch, hydropropyl starch, carboxymethyl starch, starch  
5 nanocomposites and mixtures thereof.

15. The absorbent composition of claim 12, wherein the ionic polysaccharides are selected from the group consisting of carboxyalkyl polysaccharides, carboxymethyl cellulose, carboxymethyl starch, oxidized polysaccharides, xanthan, carrageenans, pectin and  
10 mixtures thereof.

16. The absorbent composition of claim 12, wherein the fibers are selected from the group consisting of cellulose, viscose, rayon, cellulose acetate, Nylon<sup>TM</sup>, polyalkylenes, polyethylene, polypropylene, bi-component fibers, polyesters, polylactides,  
15 polypropanediols, Lyocell<sup>TM</sup>, sphagnum and mixtures thereof.

17. The use of the superabsorbent material or composition as defined in claim 1 or 11 in an absorbent product selected from the group consisting of diapers, incontinence articles, feminine hygiene products, airlaids, absorbent dressings, household articles, sealing  
20 materials, humectants for agricultural products for soil conditioning, anti-condensation coatings, water-storing materials in agriculture/horticulture/forestry, absorbent paper products, bandages and surgical pads, absorbents for chemical spills, polymeric gels for cosmetics and pharmaceuticals, and artificial snow.

18. A method for absorbing fluids selected from  
25 the group consisting of water, aqueous solutions, physiological solutions

and saline solutions comprising contacting the fluids with an absorbent product including an absorbent composition as defined in claim 11 or a superabsorbent material as defined in claim 1.

5           19. A process for the manufacture of a superabsorbent material as defined in claim 1, wherein said process comprises the steps of: dissolving galactomannan in an aqueous solution; complexing the galactomannan with a hydrophobic diol complexing agent; recovering the complexed galactomannan by heat-drying.

10           20. A superabsorbent material, as defined in claim 1, wherein the galactomannan has a galactose/mannose ratio ranging from 1:5 to 1:1